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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/682,151	07/27/2001	Martin E. Kordesch	XDEV1100	5628

7590 05/12/2004
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EXAMINER

BAUMEISTER, BRADLEY W

ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 05/12/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/682,151

Applicant(s)

KORDESCH ET AL.

Examiner

B. William Baumeister

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 11 February 2004.
2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-15 is/are pending in the application.
4a) Of the above claim(s) _____ is/are withdrawn from consideration.
5) ☐ Claim(s) _____ is/are allowed.
6) ☒ Claim(s) 1-15 is/are rejected.
7) ☐ Claim(s) _____ is/are objected to.
8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. The newly-assigned examiner finds that the requirement for restriction (paper # 5, dated 3/12/2002) did not set forth a sufficient basis for requiring restriction between the product and method claims. Without addressing the merits of Applicant's arguments in the subsequent traversal of the restriction (paper #6), it is noted that a search and examination of the method claims along with the product claims, as currently presented, would not constitute an undue burden in the present case because the examiner is contemporaneously examining the related PCT application wherein lack of unity requirements generally do not permit product/method restrictions; and the present claims are currently similar to those of the PCT application.
 - a. Accordingly, the restriction requirement is withdrawn, non-elected claims 1-8 are rejoined with the previously elected claims, and all of claims 1-15 are currently under active consideration.
 - b. The issue of restriction may be revisited at a later stage of prosecution if warranted by subsequent amendments to the claims.

Claim Objections

2. Claim 8 is objected to because of the following informalities: claim 1 sets forth forming first, second and third compound semiconductor layers. Claim 8 additionally sets forth forming a third [sic: fourth] compound semiconductor layer that includes a fourth compound semiconductor material. Appropriate correction is required.

Claim Rejections - 35 USC § 102

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1, 5, 6, 8, 9 and 15 are rejected under 35 U.S.C. 102(e) as being anticipated by Morris '097. See e.g., FIG 4e wherein the first through fourth layers (using the layer-designation terminology of the product claims—not the method claims) respectively read on GaAs-based collector 204; base 206; emitter 208 and heavily doped base contact 226. Base metal electrode 228 contacts the base contact layer 226.

a. Regarding claim 15, the base is disclosed as having a thickness of 80 nm (col. 7, TABLE 2) which is “approximately 0.1 microns” or 100 nm.

b. Also, please note that col. 6 that when the heavily-doped base contact is formed directly on the base (without an interposed wide-bandgap passivation extrinsic base layer 124) the structure still prevents metal spiking through the base layer.

4. Claims 1, 5, 6, 8, 9, 12-15 are rejected under 35 U.S.C. 102(b) as being anticipated by Sakai et al. '871.

a. See e.g., FIG 2 wherein Sakai discloses a GaAs-based (compound semiconductor) bipolar transistor including collector 3; base 4 (doped $\sim 4 \times 10^{19}$; col. 7, TABLE 1); and emitter 5, The emitter layer is patterned to define an opening (in conjunction with base

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layer 4 and regrown layers 14 and 15) with a wall (the wall of the emitter which is covered by insulating layer 12). More heavily-doped ($\sim 1e20$; col. 6, line 8) base-contact is formed in the opening. Base electrode 8 electrically contacts the base and base contact layers 4 and 16; emitter electrode electrically contacts emitter 5.

b. Regarding claim 14, first insulating layer 12 and second insulating layer 11 are formed respectively on the side and top of the emitter layers. The top surfaces of second insulating layer 11 and the metal contacts further from the substrate (base electrode 8) "lie in substantially a same plane."

c. Regarding claim 15, the base layer has a thickness of 1000 angstroms (See col. 7, TABLE 1; while the units are omitted from the table, compare col. 5, lines 2 which indicates that the units are intended to be angstroms) , or 0.1 micron.

Claim Rejections - 35 USC § 103

9. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

10. Claims 3, 4, 7, 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Morris as applied to the claims above in view of Singh et al. '675.

a. Morris teaches the limitations set forth in the preceding section, but does not expressly disclose that the bipolar transistor's material system may be specifically composed of SiC. While the reference discloses examples of GaAs-based transistors, the invention is not limited to GaAs-based transistors. Morris specifically discloses that

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implementation of that invention is contemplated in GaAs families, InP families or other electronic materials families, and also in other technology-based forms and embodiments (col. 1,2 lines 35-41).

b. Singh et al. '675 teaches that SiC bipolar transistors with heavily-doped semiconductor base contact regions were conventional. It further teaches that the properties of SiC are such that bipolar transistors composed of SiC have the capability of operating at higher temperatures, power densities, speeds, power levels and under high radiation densities relative to bipolar transistors composed of GaAs, InP or Si based-systems (col. 1, lines 50- col. 2, lines 3). Singh also teaches that these properties make SiC-based BJTs desirable for various applications as high power radio frequency transmitters for radar and communications, for high power switching applications, and for high temperature operations such as get engine control (col. 2, lines 4-12).

c. It would have been obvious to one of ordinary skill in the art at the time of the invention to have substituted SiC for the GaAs-based composition of Morris' BJT because Morris expressly states that that invention may be implemented with various material systems, including but not limited to GaAs- and InP-based systems, and because Singh teaches the advantages that SiC has over GaAs- and InP-based systems for BJTs.

d. Regarding claim 7, Singh teaches that Al was conventionally used to make ohmic contact p-type SiC (col. 8, lines 30-43).

11. Claims 3, 4, 7, 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakai as applied to the claims above in view of Singh et al. '675.

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- a. Sakai teaches GaAs-based compound semiconductor bipolar transistors that have improved high frequency gain relative to other prior-art GaAs-based transistors. Sakai does not disclose that other material systems may be substituted for GaAs.
- b. Singh et al. '675 teaches that SiC bipolar transistors with heavily-doped semiconductor base contact regions were conventional. It further teaches that the properties of SiC are such that bipolar transistors composed of SiC have the capability of operating at higher temperatures, power densities, speeds (or frequencies), power levels and under high radiation densities relative to bipolar transistors composed of GaAs, InP or Si based-systems (col. 1, lines 50- col. 2, lines 3). Singh also teaches that these properties make SiC-based BJTs desirable for various applications as high power radio frequency transmitters for radar and communications, for high power switching applications, and for high temperature operations such as get engine control (col. 2, lines 4-12).
- c. It would have been obvious to one of ordinary skill in the art at the time of the invention to have substituted SiC for the GaAs-based composition of Sakai' BJT either for the reasons set forth in Singh or alternatively because SiC has a higher operating frequency (speed) and a lower dielectric constant than GaAs (~ 6.52 vs. ~ 13.1, respectively) (resulting in a lower base-collector capacitance) thereby enabling a further increase in high frequency gain as desired by Sakai.
- d. Regarding claim 7, Singh teaches that Al was conventionally used to make ohmic contact p-type SiC (col. 8, lines 30-43).

3. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over either Morris/Singh or alternatively Sagai/Singh as applied to claim 1 above, and further in view of Luo et al., "Demonstration of 4H-SiC power bipolar junction transistors," Electronic Letters, 17th August 2000, Vol. 36, No. 17, pp.1496-1497.

a. Regardless of whether Singh teaches that the Al base electrode may be formed on the heavily-doped p-SiC base contact layer specifically by sputtering, Luo teaches that sputtering metals comprising Al was a conventional way of forming base electrodes on heavily-doped p-SiC base contact regions (see page 1496, col. 2).

Response to Arguments

4. Applicant's arguments with respect to the claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- a. Bakowski et al. '488 teaches SiC/GaN-based compound-semiconductor HBTs with regrown heavily-doped base contact regions (see e.g., FIG 4).
- b. Shigematsu et al. '971 teaches regrown, heavily doped base contact regions for compound semiconductor bipolar transistors which are separated from the emitter by an insulating layer.

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- c. Chen teaches BJTs with heavily doped base contact regions and discloses that the device may be composed of SiC (col. 5, line 18).
- d. Zeghbroeck '745 (not prior art)
- e. Tang et al., "An Implanted-Emitter 4H-SiC Bipolar Transistor with High Current Gain," IEEE Electron Device Letters, Vol. 22, No. 4, March 2001, pp. 119-120.

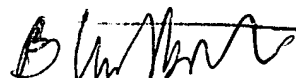
Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to B. William Baumeister whose telephone number is (571) 272-1722. The examiner can normally be reached on M-F 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571) 272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

**BRADLEY BAUMEISTER
PRIMARY EXAMINER**



B. William Baumeister
Primary Examiner
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May 8, 2004